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FINAL REPORT: MULTI-DISCIPLINE ARCTIC OCEANOGRAPHY AND ACOUSTICS PROGRAM - THE GEODESIC UNDERICE TRAMWAY SYSTEM - GUTS

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ABSTRACT

The Multi-Discipline Group was engaged in a research program for FY91-92 in Arctic oceanography and acoustic scattering. The purpose of this project was to develop and operate a system capable of accurately mapping the topography and elastic constants of sea ice with spatial precision to a fraction of a meter (required to characterize the Bragg wavenumber structure for acoustic backscatter studies). The system would be capable of conducting detailed oceanographic studies under the ice canopy, where ice topography and heat and salt budgets are difficult to study over wide areas, and in shallow bay areas where near-surface processes are important. The main research objective was to complete the dynamic analysis, mechanical design, construction and testing of the Geodesic Underice Tramway System (GUTS). A secondary objective was to work with research scientists in oceanography, ice mechanics and acoustics on the development of instrument suites to be carried by the apparatus.

LONG-RANGE OBJECTIVES

The Arctic Ocean Acoustic Scattering Program sought to understand how internal waves, the ice canopy and other arctic ocean processes affect acoustic propagation. An important adjunct goal was to understand deterministically the physics of acoustic scattering from the ice canopy.

INTRODUCTION

The Geodesic Underice Tramway System (GUTS) is a device capable of placing an instrument-carrying package under the ice at precisely located positions over scales roughly 800 m by 300 m. The array would be capable of generating maps of the underside of the ice, providing information on the oceanographic properties of the ocean in the ice/water boundary layer, and, via tomographic methods, giving the elastic properties of the ice interior. The system (Figure 1) consists of a large virtual mass (tram car) suspended ~ 50 m under the ice by 3 very taut cables. An instrument carrier is buoyed up from the tram car by a cable that passes over a line-haul type winch on the tram car to a counterweight beneath it. Computer simulations showed that the oscillations of the tram car are very slow, and the instrument carrier could be maintained along

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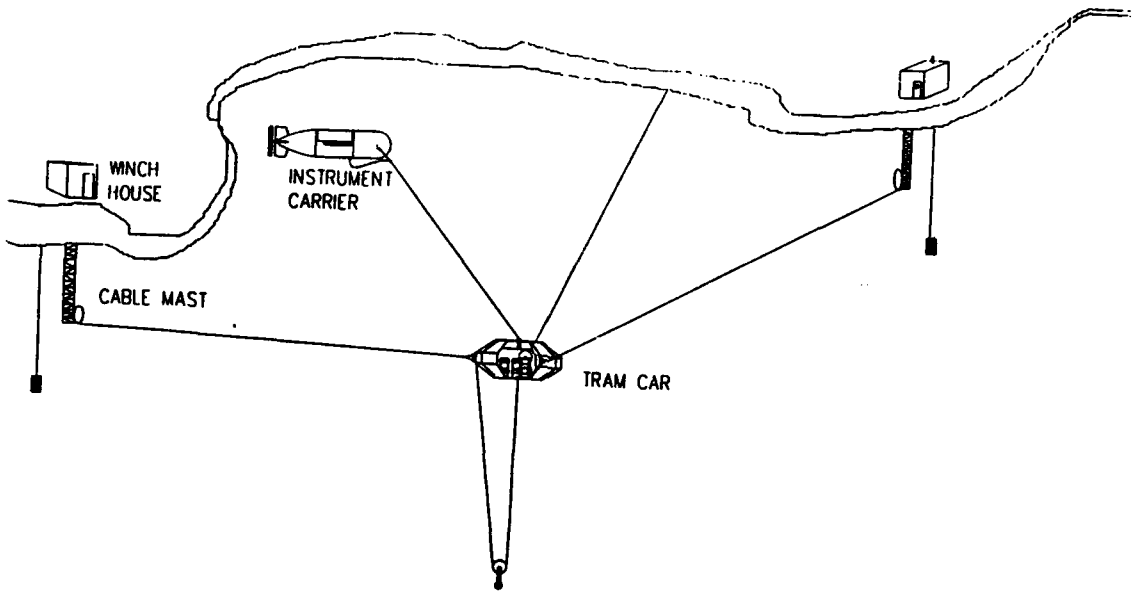

Figure 1. The Geodesic Underice Tramway System (GUTS). The major components of the array are: the instrument carrier, a counterbalance and a tram car that is a large, virtual mass supported and positioned by high tensioned cables and winches. The instrument carrier floats above the tram car; the counterbalance hangs beneath. The array will allow underice sampling over a 300 by 800 m elliptical patch with dynamical positioning of the instrument carrier to fractions of a meter.

an x-y trajectory at constant depth.

GUTS would allow measurements to be made of ice and ice-ocean boundary layer properties during experiments to study 1) deterministic acoustic scattering characteristics for forward and back acoustic scattering from the ice; (2) the topographic and mechanical properties of the sea ice in three dimensions; and (3) the mapping of temperature, salinity and velocity fields in the ice-ocean boundary layer.

PROGRESS

Feasibility studies for the Geodesic Underice Tramway System were completed during 1990. A report (APL-UW TM5-90, April 1990) detailing the result of our model demonstrated that the dynamics of the system are understood, and that mapping objectives could be achieved. The equations of motion and the dynamic feedback control equations were precisely those needed to operate the control system. This would be accomplished on our Concurrent real time UNIX machine in a manner identical to control of the AATE winches during AIWEX.

Conceptual designs of the major components were developed early in FY91. In order to estimate system parameters, a dynamic computer model was created using these designs. The model assumes the survey area to be a 300 m by 800 m ellipse.

Final designs of the winch systems and preliminary drawings of the data acquisition system and tram car were completed. Under separate funding, a workshop was convened to discuss the

experiment and instrumentation for GUTS in December, 1991. The concept and designs for the system were presented there.

Funding for this project was halted during early FY92. All modeling results, drawings and design plans have been filed.

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